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# ON THE EASTERN EXTENSION OF THE CRETACEOUS ROCKS IN KANSAS AND THE FORMATION OF CERTAIN SANDHILLS.

By ROBERT HAY, Junction City, Kan.

Twenty years ago I obtained from the sandy bed of the creek at St. George, in Pottawatomie county, the cast of an Inoceramus of a Dakota form. I decided at the time that it had been brought there by the ice from Nebraska or Dakota. Two years later I obtained, in glacial gravel in Jackson county, cretaceous sharks' teeth and a fragment of an ammonite of the genus Placenticeras. This confirmed my previous conclusion as to the Pottawatomie specimen. In 1883 I ascertained that water of Arrington spring came from a highly ferruginous coarse sand, which seemed to be the debris of Dakota sandstones not far removed from its original site. Again, the suggestion of Nebraska was made by the direction of the ice movement; but whether it might not be Kansas was a question. The most easterly outcrop of the Dakota then known in the state was in the northeast of Washington county. Its full development there, and the fact since ascertained that glacial boulders lie on it in that county, suggested the idea that it might have been in force much further east up to the glacial erosion. These facts suggest that outliers of the Dakota, patches of what was once a continuous area, may be found some time in Marshall and Pottawatomie counties, and even in Nemaha or Jackson, perhaps quite to the river.

In 1887 I found, in the well of the waterworks at Junction City, a bed of ferruginous sand, as my note book of the date says "almost sandstone," that shows that its origin was the Dakota, not far away. At the same time, on the top of the hill by the Catholic cemetery (in sec. 14, T. 12, R. 5 E.) I found a small deposit of gravel composed entirely of the hard nodules of the dark ferruginous Dakota sandstones. Again I found fragments of the sandstone itself, turned up by the plow, near the Dickinson county line, seven miles west of Junction City. But still the most eastern outcrop in the region that I know of was just on the west side of the city of Abilene, or 15 miles north on the Clay-Dickinson county line, near Industry. There was no outcrop in Geary county.

In November of 1893 I was bid to make a closer examination of a district southwest of Junction City, where some accumulations of sand had often puzzled me. I had attributed the sand, at that elevation, 200 to 300 feet above Smoky river, to the prevalence of the south wind. But the condition of the river alluvium in that direction was such as always to make me dissatisfied with the conclusion. Now I obtained a better solution. In a shallow ravine, where the grass is always long, I found an outcrop, or rather outlier of Dakota sandstone, of the softer yellowish red variety, and a quarter of a mile away another patch of the harder ferruginous qualities. I had crossed these depressions before, but had not hit the right places, and the grass concealed them from all but close vision. Then, north of these, the sand accumulations, which I had taken to be exceptionally hard packed dunes, showed, by digging at their southern ends, that they were the packed sand, or loose sandstone, that is conspicuous about Industry. It is unmistakably the Dakota, and several parallel ridges are of it, and the loose sand at the north is wind-blown only to a small extent. As far as there are dunes here, they are nearly on the site of the sandstones, more or less incoherent, of which they are the debris. These appearances are on sections 21, 16, and 17, of town 12, range 5 east, the two harder rock patches being on section 21. The region to the west of these has largely a sandy soil for several miles, and though both to the north and west, and conspicuously to the south, the Permian rocks are at greater elevations, here is an area of eastern prolongation of the Dakota, resting on an eroded hollow of the older formations. The prolongation of a Dakota tongue on the south of Dickinson county suggests that the phenomena I have described might be expected. Till now, however, they have not been recorded. The geological map of the state should now show Dakota in Geary county.

The consideration of all these facts suggests other inquiries. Has the the erosion of the Kaw valley spared other patches that may testify to the former existence of the cretaceous further east? Is the sand mass—stone or otherwise—at St George a relic of the Dakota?

Five years ago I found, under the sandhills of the northern part of Reno county, that the red beds were well developed. Over in Rice county the Dakota is in force; but a remarkable erosion makes it absent where the first gas well was bored at Lyons. Further north and east, the thin limestones of the Benton are also found.

In Rice county, near the Reno county line, nearly straight north of Hutchinson, there is a region of sandhills, a large area of which is inclosed as pasture. In this pasture on section 10, township 21, range 6 west, is a continuous sandy ridge with hard ferruginous rock appearing through it in small patches for from a quarter to half a mile from west to south of east. It is the Dakota sandstone with the vitreous surfaces, and people in the district say it is of volcanic origin. Breaking the ferruginous surface, which has the vitreous coat, I found under it only soft, dark yellow or red, somewhat incoherent sandstone. It could be cut by the spade. The ferruginous streak has hardened and protected it till now at this spot, while all around the agencies of the weather have broken up the body of soft sandstone, and the winds have piled up the incoherent mass into sand dunes, which grass is now again rendering stationary. In the cut on the Rock Island railway, a few miles northeast of Hutchinson (sec. 33, T. 22, R. 5 west), similar soft sandstones are exposed, and the district to the east and west is made of grass-grown sandhills. A small patch of the vitreous, ferruginous nodular stone is also just north of the Reno-Rice county boundary in 33, 21, 6; and this, with the one in section 10, is in the sandhill region, most of which has been redeemed by grass. The county in the neighborhood of these two is practically level, except the irregularity of the sandhills, and there is descent to the north and east to the Little Arkansas and its tributaries, and southward to the Arkansas, and the sheet of the Dakota was thin before its weathering into sandhills began.

Sandhills thus formed from subjacent sandstones might be described by a term taken from a description of soils similarly formed, and called sedentary sandhills; and it is probable that a large proportion of the sandhills of the world are so formed. It is remarkable that while sand travels with the wind, a region of sand dunes is stationary. The mass remains; the molecules are in motion. There are regions where the wind, persistent in one direction, has caused an arenaceous desert to encroach on the regions beyond; but it will be found that large areas are like those described above, and some tertiary regions I have described elsewhere, and composed of sedentary sand dunes. Besides those mentioned above, the sandhill region west of Abilene belongs to this class.

I will make here a further note on easterly extension of the cretaceous and refer briefly to some beds higher than the Niobrara, which are well developed in northwestern Kansas. Eleven years ago, in this Academy, I drew attention to some shale in Norton county in that position. I have now no doubt that these higher shales belong to the Fort Pierre group. At the mouth of Prairie Dog creek, just over the line in Nebraska, they are developed strongly, and all the way from this west up the Republican valley and all its forks, as well as the Sappa and Beaver valley. In the former, this goes way into Colorado; on the South Fork, to its very head; and they are developed very strongly north of the Union Pacific road from Hugo to Limon. The eastern front in Kansas is not all shown; but it may be presumed there is some in the northwest of Phillips county, and on the Prairie Dog-Solomon watershed, and in Graham county and northern Gove. They show well above the Niobrara on the slope to the Smoky south of Winona, in Logan county. There are abundant outcrops on both forks of the Smoky, but the east front on the south is over on Butte creek, and is shown again on the White Woman, in Greeley county. I am not certain that here I have found its further extension: but, as it does not show in the Arkansas valley in Kansas, it may be assumed that its trend south of latitude 38 degrees 30 minutes is west.

The general direction of this trend of the easterly front is roughly parallel with what we have understood usually is the direction of the east front of the other cretaceous formations.

One or two paleontologic facts are in evidence as to the age of these shales. I have before me, as I write, specimens of Baculites ovatus, which were obtained in what is now Logan county, 20 years ago. This year I have obtained Inoceramas crispii, var. barabini, from the shales of the Republican valley, just east of Benkelman, Neb.; and in Cheyenne county, Kansas, I have obtained both the Baculite and the Inoceramus. These are characteristic Fort Pierre fossils. Lucina is also in the shales in Colorado.